

Adoption Status of Improved Crop Production Practices in *Bt*-cotton in Sri Muktsar Sahib, Punjab

Karamjit Sharma^{1*}, N.S. Dhaliwal² and Chetak Bishnoi³

ABSTRACT

The present study was conducted to investigate the adoption status of crop production practices in *Bt*-cotton in Sri Muktsar Sahib District of Punjab. The data were collected from 140 cotton growers through personal interviews during two consecutive years (2016-17 and 2017-18). These data analysis revealed that area under *Bt*-cotton increased by ~10.9 per cent in 2017-18, compared with 2016-17. A large majority (~80%) of farmers ensured cotton sowing in the recommended time period, with the use of 900-1100 g acre⁻¹ seed rate. This survey showed that farmers did not prefer soaking of seed and *refugia* in the study region. These results highlight that ~65 per cent of farmers were applying fertilizer-N as per recommended rate, while ~30 per cent farmers were applying fertilizer-P as per recommendation. These (57% of total farmers) farmers were applying 5 irrigations to cotton, while 7 irrigations were applied by only those farmers who had very light textured soils. A great majority of farmers (~83%) were using manual method for weed control in *Bt*-cotton, and ~44.0 per cent were using 3-5 sprays for management of sucking pests. The seed cotton yield of *Bt*-cotton prominent hybrids varied from 17.5- 23.5 q ha⁻¹, with a mean 19.4 q ha⁻¹. These results highlight the need of intensified extension efforts to disseminate the technology developed for efficient nutrient, water and insect-pest management for yield maximization in *Bt*-cotton in Sri Muktsar Sahib District of Punjab.

Keywords: Adoption status, *Bt*-cotton, Crop production practices, Seed cotton yield

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is globally the most important commercial fibre crop and is used by 75 per cent of world's population for textile purpose (Yadav *et al.*, 2018). Its cultivation predominates in arid and semi-arid environment under rainfed and irrigated conditions. Cotton requires high temperature and radiation requirements (Constable and Bange, 2015) and is cultivated during summer season after wheat (*Triticum aestivum* L.) in an annual cotton-wheat cropping system (Singh *et al.*, 2018). In south-western Punjab (India), cotton-wheat is the second largest cropping system only next to rice-wheat which is practiced mainly on light textured, low fertility soils and poor quality under-ground

irrigation water conditions (Singh *et al.*, 2020a). Poor plant population due to high seedling mortality under prevailing high temperature conditions lead to a significant set-back on cotton productivity (Tariq *et al.*, 2017; Ahmad *et al.*, 2017). On the other side, rainfall particularly during flowering and bolting stage negatively impacts the cotton yields (Cetin and Basbag, 2010). Besides, severe attack of cotton whitefly (*Bemisia tabaci*) resulted in a drastic decline in *Bt*-cotton yield during the year 2015 (Singh and Sharma, 2016).

Cotton productivity is influenced by selection of improved varieties/hybrids, fertilizer management, irrigation water availability, soil fertility and insect pest management (Sabesh *et al.*, 2014). Starting with seed

¹Professor, ²Associate Director, ³Assistant Professor, Krishi Vigyan Kendra, Sri Mukatsar Sahib, Punjab

*Corresponding author email id: sharamkaramjit@pau.edu

germination which is reduced due to delayed emergence in the salt-affected soils (Qadir and Shams, 1997), high salinity level also adversely affects photosynthesis to cause significant set-back on cotton productivity. Seedling mortality under prevailing high temperature and under late sown conditions leads to significant yield losses (Tariq *et al.*, 2017; Ahmad *et al.*, 2017). Cotton is susceptible to insect-pests attack and adoption of suitable plant protection measures has a significant effect. Faulty spray practices including indiscriminate use of insecticides with a repeated use of same chemicals and/or cocktails of chemicals and cultivation of un-recommended hybrids are important factors affecting cotton productivity and economic returns (Khan *et al.*, 2015). Efficient agricultural extension services comprised each such activity that provides the information and advisory services required and demanded by the farmers. Such programmes are launched to strengthen farmer's capacity by providing access to knowledge and information (Ragasa *et al.*, 2013). Cavatassi *et al.* (2010) reported that agricultural programmes enhanced crop yields both through a general shift in technology as well as increased input-use efficiency. The success of any extension programmes is judged by the adoption of improved practices and thus evaluation of the extension programmes has significant importance (Peshin *et al.*, 2009; Singh *et al.*, 2020b). The present study was therefore conducted to study the current adoption status of recommended practices and shift in area under Bt-cotton in Sri Muktsar Sahib district of Punjab.

METHODOLOGY

Present study was conducted during the year 2016-17 & 2017-18 in Sri Muktsar Sahib District of Punjab. The district was purposively selected. A detailed survey of Bt-cotton crop was performed during two consecutive years 2016-17 to 2017-18. Farmers from each of four blocks viz. Muktsar, Malout, Lambi and Giddarbaha were proportionally selected and thus, total sample size was 70 farmers (25+20+15+10 = 70) were contacted during 2016-17 and again during 2017-18. From different blocks farmers having at least 5 years of farming experience were proportionally but randomly selected. Survey information was recorded in questionnaire developed for

the purpose of the study. During second year (2017-18) data regarding area under Bt-cotton, hybrids grown, agronomic practices followed and seed cotton yield obtained was collected for the purpose of the study. Cross validation of the data collected during previous year was also done. For the purpose of data collection a questionnaire was developed and administered to the selected respondents. The questionnaire contained two parts. Part I was developed to gather information regarding shift in area and Part II dealt with management practices adopted by Bt-cotton growers. The data gathered was analyzed using mean, frequencies and percentages.

RESULTS AND DISCUSSION

The total area under Bt-cotton of respondent farmers was 201.8 ha during 2016-17 and it increased to 223.8 ha in 2017-18 (Table 1). These results showed an increase of 22.0 ha (~10.9%) in area under Bt-cotton by selected respondents during 2017-18 as compared to year 2016-17. The deliberations with the respondent farmers revealed that reasons for enhancing area under cotton were increased cotton yield, effective management of whitefly and fetched good market price of cotton.

Table 1: Details of total area under Bt-cotton cultivation in the study region

Year	Total area (ha)	Area under cotton (ha)	Percent change in area under cotton
2016-17	451	201.8	-
2017-18	451	223.8	-
-	-	+22	+10.9%

The area shifted from rice and basmati crop to Bt-cotton was from 7.1 per cent and 1.2 per cent, respectively of the total area shifted (Table 2). The number of farmers who shifted area from these crops were ~22.9 and 2.4 per cent, respectively. However, the area shifted from cluster bean to Bt-cotton was ~1.0 per cent of the total shift in area. The rice farmers shifted area towards Bt-cotton due to low rice yield in non-rice area and shift from cluster bean crop was due to less economic returns from cluster bean as compared with Bt-cotton. On an average, ~11.0 per cent increase in area

Table 2: Distribution of farmers based on shift in area towards *Bt*-cotton crop from other crops in Sri Muktsar Sahib District of Punjab

Area shifted from crops	No. of farmers	Shift in area (ha)	% of total area
Rice	16 (22.9)†	14.4	7.1
Basmati	2 (2.9)	2.4	1.2
<i>Desi</i> cotton	1 (1.4)	1.2	0.6
Vegetables	1 (1.4)	2	1.0
Cluster bean	1 (1.4)	2	1.0
Others		0	0.0

†Figures in parenthesis are percentages

under *Bt*-cotton was observed during 2017-18, compared with 2016-17. These results corroborate the earlier findings of Singh *et al.* (2018) who observed that farmers prefer to adopt *Bt*-cotton due to higher yield which leads to higher economic returns. These results revealed that majority of the farmers (~79.3%) used seed rate of 900-1100 g acre⁻¹ (Table 3). About 14 per cent of the farmers used seed rate in the range of 1350-1450 g acre⁻¹, while ~7.0 per cent of the farmers used lower seed rate (600-750 g acre⁻¹).

Table 3: Distribution of farmers according to adoption of *Bt*-cotton cultivation practices in Sri Muktsar Sahib district of Punjab

Cultivation practices	Year		Overall
	2016-17	2017-18	
Seed rate (g acre ⁻¹)			
600-750	7 (10.0)	3 (4.3)	5 (7.1)
900-1100	49 (70.0)	62 (88.6)	111 (79.3)
1350-1450	14 (20.0)	5 (7.1)	19 (13.6)
Fertilizer-N			
<Recommended	12 (17.1)	14 (20.0)	26 (18.6)
Recommended	46 (65.8)	45 (64.3)	91 (65.0)
>Recommended	12 (17.1)	11 (15.7)	23 (16.4)
Fertilizer-P			
<Recommended	0 (0.0)	0 (0.0)	0 (0.0)
Recommended	20 (28.6)	21 (30.0)	41 (29.3)
>Recommended	50 (71.4)	49 (70.0)	99 (70.7)
Fertilizer-K use			
<Recommended	0 (0.0)	0 (0.0)	0 (0.0)
Recommended	32 (45.7)	39 (55.7)	71 (50.7)
>Recommended	38 (54.3)	31 (44.3)	69 (49.3)

Table 3 contd....

Cultivation practices	Year		Overall
	2016-17	2017-18	
No. of KNO ₃ sprays			
0	12 (17.1)	10 (14.3)	22 (15.7)
1	2 (2.9)	2 (2.9)	4 (2.8)
2	36 (51.4)	27 (38.5)	63 (45.0)
3	14 (20.0)	21 (30.0)	35 (25.0)
4	6 (8.6)	10 (14.3)	16 (11.4)
Irrigations (No.)			
3	5 (7.1)	3 (4.3)	8 (5.7)
4	12 (17.1)	10 (14.3)	22 (15.7)
5	38 (54.3)	42 (60.0)	80 (57.1)
6	13 (18.6)	12 (17.1)	25 (17.9)
7	2 (2.9)	3 (4.3)	5 (3.6)
Weed management method			
Manual	57 (81.4)	59 (84.2)	116 (82.9)
Chemical	6 (8.6)	4 (5.8)	10 (7.1)
Manual + Chemical	7 (10.0)	7 (10.0)	14 (10.0)
Herbicides			
Pendimethalin 30 EC	4 (5.8)	5 (7.1)	9 (6.4)
Paraquat dichloride	3 (4.3)	7 (10.0)	10 (7.1)
Glyphosate acid	1 (1.4)	1 (1.4)	2 (2.9)
Pyrithiobac Sodium 10 EC	3 (4.3)	1 (1.4)	4 (5.8)
Propaquizafop 10 EC	2 (2.9)	—	2 (2.9)
Insecticide sprays (No.)			
1-2	—	—	—
3-5	3 (4.3)	58 (82.9)	61 (43.6)
6-8	22 (31.4)	12 (17.1)	34 (24.3)
> 8	45 (64.3)	0 (0.0)	45 (32.1)

The survey highlights that lower seed rates were used by those farmers who adopted dibbling method of sowing or followed ridge sowing. A large majority of farmers (~95%) drilled seed without soaking prior to sowing and 2/3rd (~64.3%) did not use *refugia* seed along with *Bt*-cotton seed (Figure 1). The lack of seed soaking practices leads to poor seed germination, however farmers reported difficulty in drilling of soaked seed. Similarly, farmers did not use *refugia* seed due to poor yield from this seed and increased attack of insect pests.

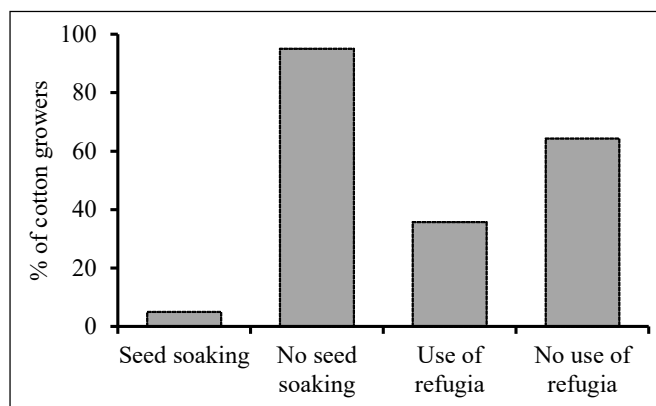


Figure 1: Seed soaking and use of *refugia* in *Bt*-Cotton in Sri Muktsar Sahib District of Punjab

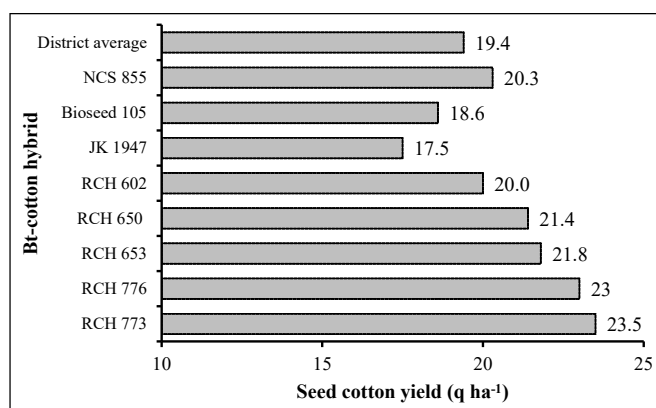


Figure 2: Mean seed cotton yield of prominent *Bt*-cotton hybrids under cultivation in the Sri Muktsar Sahib District of Punjab

The recommended time for sowing of *Bt*-cotton in the study area was 16th of April -15th of May. More than 80 per cent of the farmers sow the *Bt*-cotton during the recommended sowing period. However, ~17.0 per cent farmers reported delayed sowing due to non-availability of canal water (Table 3). Majority (~23.0%) were following cotton-mustard cropping sequence instead of cotton-wheat reported early sowing from 16-30th of April. Only ~4 per cent of the farmers had re-sown *Bt*-cotton crop very late (1-15th of June) in the season due to failure of earlier sown cotton crop by rain showers immediately after sowing. Singh and Sharma (2016) observed poor quality of ground water, high incidence of sucking pests and low yield in case of delayed sowing were some of the limiting factors for the adoption of *Bt*-cotton in south western districts of Punjab. Therefore, farmers preferred to sow cotton during the

recommended time period. Data on fertilizer use pattern in *Bt*-cotton revealed that ~2/3rd (65.0%) farmers were using fertilizer-N in the recommended range. However, ~20 per cent were using fertilizer-N below the recommended level. Similarly, ~17.0 per cent of the surveyed farmers were using fertilizer-N above the recommended dose. In case of fertilizer-P, none used below the recommended level, ~30 per cent used recommended dose while ~71.0 per cent used higher doses than recommended level.

The results revealed that ~51 per cent of the respondents used fertilizer-K in the recommended rate, while ~49 per cent were using higher doses than the recommended range. To enhance seed cotton yield and improve fibre quality research system has recommended four sprays of 2 per cent KNO₃ ha⁻¹ during flowering. The extension system continuously promoted use of KNO₃ to improve yield and quality of fibre. Data revealed that majority (~45%) were using 2 sprays of 2 per cent solution of KNO₃ during flowering (Table 7). One fourth of the farmers were applying 3 sprays, while ~11 per cent were applying 4 sprays of KNO₃. However, ~16 per cent of the farmers did not apply KNO₃, and ~2.8 per cent used only one spray. The extension agencies can play a role in filling adoption gaps by educating farmers regarding role of different nutrients in getting high crop yield (Singh *et al.*, 2017).

Majority of the farmers (~57%) applied 5 irrigations to *Bt*-cotton followed by ~18 per cent of the farmers who applied 6 irrigations. About 4 per cent of the farmers having light texture soils applied 7 irrigations to the *Bt*-cotton crop. Farmers having heavy textured soils or where frequent rainfall occurred applied less number of irrigations, and these ~6 per cent of the farmers applied only 3 irrigations to the *Bt*-cotton. There were ~16 per cent of the *Bt*-cotton growers who applied only 4 irrigations based on soil texture and rainfall occurrence.

A great majority of farmers (~83%) were using manual method for weed control in *Bt*-cotton. The tractor drawn *tirphali* is used by the farmers to control weeds in *Bt*-cotton. About 7 per cent used only chemical control measure for weed control and Pendimethalin 30 EC, Paraquat dichloride, Glyphosate acid, Pyriithiobac

Table 4: Hybrid/variety wise sowing time of *Bt*-cotton in Sri Muktsar Sahib District of Punjab

<i>Bt</i> -Cotton hybrids	16-30 th April	1-15 th May	16-31 st May	1-15 th June	Total	% of grand total
RCH 650	9.0	15.0	10.5	0.0	34.5	7.0
RCH 776	4.0	36.8	9.7	0.0	50.5	10.3
Ankur 3028	20.8	27.5	12.0	0.0	60.3	12.3
NCS 855	1.5	5.0	2.5	0.0	9.0	1.8
MRC 6588	11.0	30.5	7.0	4.0	52.5	10.7
RCH 773	50.0	104.0	22.2	0.0	176.2	35.9
RCH 653	0.5	22.2	6.0	0.0	28.7	5.9
Bioseed 105	0.0	14.3	0.0	0.0	14.3	2.9
RCH 602	9.2	10.3	0.0	0.0	19.5	4.0
Bioseed 100	0.0	3.0	2.5	0.0	5.5	1.1
Others	5.8	23.7	7.0	0.0	36.5	7.5
<i>Desi cotton</i>	0.0	2.7	0.0	0.0	2.7	0.6
Grand total	111.8	295	79.4	4.0	490.20	100.0
% of grand total	22.8	60.2	16.2	0.8	100.0	—

Sodium 10 EC and Propaquizafop 10 EC were the major chemicals used for weed control in *Bt*-cotton. Ten percent of the farmers used manual + chemical weed control measures. The attack of sucking pests viz. whitefly, jassid, thrips were the major pests of *Bt*-cotton in the study area. The data revealed that ~44.0 per cent were using 3-5 sprays for management of sucking pests. About 1/4th (~24.3%) were using 6-8 sprays while ~32 per cent were using >8 sprays. The majority of sprays were done for whitefly and jassid. These results revealed that among the different *Bt*-cotton hybrids grown in the district, the largest area was under RCH 773 (~35.9% of total area) followed by Ankur 3028 (~12.3%), MRC 6588 (~10.7%), RCH 776 (~10.3%) and RCH 650 (~7.0%).

The seed cotton yield of all the *Bt*-cotton hybrids was lower than their potential yield of due to attack of insect pests, *parawilt* (physiological disorder), poor soil fertility and imbalance use of fertilizers. Mean seed cotton yield of *Bt*-cotton prominent hybrids varied from 17.5- 23.5 q ha⁻¹ (Figure 2). The data clearly shows that *Rashi* hybrids had higher seed cotton yield as compared to other hybrids. The highest yield of *Bt*-cotton was observed for RCH 773 followed by RCH 776. The mean seed cotton yield of *Bt*-cotton hybrids was 19.4 q ha⁻¹ for the year 2017-18.

CONCLUSION

The data collected regarding area shift, hybrids and cultivation practices in *Bt*-cotton revealed that area under *Bt*-cotton increased during 2016-17 to 2017-18 due to successful management of whitefly. However, excessive use of fertilizer-N by farmers may results in enhanced attack of sucking pests therefore, there is a need of intensified extension efforts for disseminating the technology for efficient nutrient management and integrated pest management among the cotton growers. These results revealed that farmers were deviating from PAU recommended practices which are causing a decrease in seed cotton yield of majority of *Bt*-cotton hybrids grown in the district. Therefore, extension efforts must be strengthened to create awareness among the farmers regarding scientific cultivation of *Bt*-cotton in the district.

Paper received on : March 14, 2021

Accepted on : April 02, 2021

REFERENCES

Ahmad, S., Abbas, Q., Abbas, G., Fatima, Z., Atique-ur-Rehman Naz, S. and Hasanuzzaman, M. (2017). Quantification of climate warming and crop management impacts on cotton phenology, *Plants*, **6**, 1-16.

- Cavatassi, R., Salazar, R., González-Flores, M. and Winters, P. (2010). How do agricultural programmes alter crop production? Evidence from Ecuador, *Journal of Agricultural Extension*, **62**, 403-428.
- Cetin, O. and Basbag, S. (2010). Effects of climatic factors on cotton production in semi-arid regions - A review, *Research on Crops*, **11**, 785-791.
- Constable, G.A. and Bange, M.P. (2015). The yield potential of cotton (*Gossypium hirsutum* L.). *Field Crops Research*, **182**, 98-106.
- Khan, M. and Damalas, C.A. (2015). Factors preventing the adoption of alternatives to chemical pest control among Pakistani cotton farmers, *International Journal of Pest Management*, **61**, 9-16.
- Peshin, R., Dhawan, A.K., Kranthi, K.R. and Singh, K. (2009). Evaluation of the benefits of an insecticide resistance management programme in Punjab in India, *International Journal of Pest Management*, **55**, 207-220.
- Qadir, M. and Shams, M. (1997). Some agronomic and physiological aspects of salt tolerance in cotton (*Gossypium hirsutum* L.), *Journal of Agronomy and Crop Science*, **179**, 101-106.
- Ragasa, C.A., Dankyi, P., Acheampong, A., Nimo-Wiredu Chapoto, M. and Asamoah, A. (2013). Patterns of adoption of improved rice technologies in Ghana: Ghana Strategy Support Program and *International Food Policy Research Institute*, Working Paper No. 35.
- Sabesh, M., Prakash, A.H. and Bhaskaran, G. (2014). Shift in Indian cotton scenario due to shift in cotton production technology, *Cotton Research Journal*, **6**, 75-82.
- Singh, G. and Sharma, A. (2016). Analysis of constraints faced by *Bt*-cotton growers in Mansa district of Punjab, *Rajasthan Journal of Extension Education & Rural Development*, **25**, 201-205.
- Singh, G., Singh, P. and Sodhi, G.P.S. (2018). Farmers' perception towards pigeon pea cultivation as an alternate to *Bt* cotton in South-western Punjab, *Indian Journal of Extension Education*, **54**, 171-179.
- Singh, G., Singh, P., and Sodhi, G.P.S. (2017). Assessment and analysis of agriculture technology adoption and yield gaps in wheat production in sub-tropical Punjab, *Indian Journal of Extension Education*, **53**, 70-77.
- Singh, G., Singh, P., Sodhi, G.P.S. and Tiwari, D. (2020b). Adoption status of rice residue management technologies in south-western Punjab, *Indian Journal of Extension Education*, **56** (3), 76-82.
- Singh, P., Singh, G. and Sodhi, G.P.S. (2020a). Productivity, profitability and sustainability of rice-(capsicum + peas) and rice-wheat cropping systems in sub-tropical south-western Punjab, *Indian Journal of Extension Education*, **56**(1), 88-95.
- Tariq, M., Yasmeen, A., Ahmad, S., Hussain, N., Afzal, M.N. and Hasanuzzaman, M. (2017). Shedding of fruiting structures in cotton: factors, compensation and prevention, *Tropical and Subtropical Agro-ecology*, **20**, 251-262.
- Yadav, S., Godara, A.K., Nain, M.S. and Singh, R. (2018). Perceived constraints in production of *Bt* cotton by the growers in Haryana, *Journal of Community Mobilization and Sustainable Development*, **13**, 133-136.